

## CLAIMS

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

- 5           1.     A color measurement instrument comprising:  
  
              illuminator means for illuminating a sample;  
  
              color measurement means for measuring light reflected from said sample;  
  
              temperature changing means for changing the temperature of said illuminator  
means;  
  
10           temperature sensing means for sensing the temperature of said illuminator means;  
  
              and  
  
              control means responsive to said temperature sensing means for controlling said  
temperature changing means to control the temperature of said illuminator means.
2.     A color measurement instrument as defined in claim 1 wherein said illuminator  
15           means includes a light emitting diode (LED).
3.     A color measurement instrument as defined in claim 1 wherein said illuminator  
means includes an illuminator and a thermally conductive base supporting said illuminator.
4.     A color measurement instrument as defined in claim 3 wherein said temperature  
changing means and said temperature sensing means are mounted on said base.
- 20           5.     A color measurement instrument comprising:  
  
              an illuminator;  
  
              a color measurement engine; and  
  
              control means for actively controlling the temperature of said illuminator.

6. A color measurement instrument as defined in claim 5 wherein said illuminator includes a light emitting diode (LED).

7. A color measurement instrument as defined in claim 5 wherein aid illuminator further includes a thermally conductive base, said control means coupled to said base.

5 8. A color measurement instrument as defined in claim 7 wherein said control means includes:

a temperature sensing element supported by said base; and  
a temperature changing element supported by said base.

9. A method of measuring color comprising the steps of:  
10 illuminating a sample with at least one illuminator;  
measuring light reflected from the sample; and  
controlling the temperature of the at least one illuminator to enhance the  
uniformity of at least one output characteristic.

10. A method as defined in claim 9 wherein:  
15 the at least one illuminator comprises a light emitting diode (LED); and  
the at least one output characteristic includes intensity, spectral energy  
distribution, and spatial distribution of the light from the LED.

11. A method as defined in claim 9 wherein said controlling step includes:  
measuring the temperature of the illuminator;  
20 comparing the temperature of the illuminator with a desired temperature; and  
applying heating or cooling to the illuminator depending on said comparing step.

12. A color measurement instrument comprising:  
an illuminator;

driver means for driving the illuminator at a selected frequency;

a photodiode responsive to light modulating at the selected frequency and to other light;

5 a transimpedance amplifier having a pair of inputs connected across said photodiode, said amplifier having an output; and

an integrator having an input connected to said amplifier output, said integrator having an output connected both to said photodiode and to one of said amplifier inputs, said integrator having a first cut-off frequency below the selected frequency, whereby said amplifier and integrator cancel the effect of light modulating at frequencies below the first cut-off  
10 frequency.

13. A color measurement instrument as defined in claim 12 further comprising a high-pass filter having an input connected to said amplifier output, said high-pass filter having a second cut-off frequency, whereby said high-pass filter provides additional attenuation of frequencies below the second cut-off frequency.

15 14. A color measurement instrument as defined in claim 12 wherein the low-pass filter cut-off frequency is greater than approximately 250 Hz.

15. A color measurement system comprising:

illuminator means for illuminating a target sample;

sensor means for sensing light reflected by the target sample; and

20 lens means for imaging a target area of said target sample onto said sensor means when said lens means is within a predetermined distance range of the target sample, the target area varying in size with the distance between said lens means and the target sample, said lens means providing a generally uniform product of the target area as the first factor and the solid

angle captured by said lens means as the second factor for all distances within said predetermined distance range.

16. A color measurement instrument as defined in claim 15 wherein said sensor means comprises:

- 5                   a photosensitive device having an image plane; and  
                  a mask adjacent said image plane and defining the target area viewed by said photosensitive device.

17. A color measurement instrument as defined in claim 15 wherein said illuminator means provides generally spatially uniform illumination within the predetermined distance  
10 range.

18. A color measurement instrument comprising:

- an illuminator providing illumination to a target sample;  
                  a photo detector responsive to light reflected from the target sample; and  
                  a lens system for imaging a target area of the target sample onto said photo  
15 detector, the target area varying in size with variations in the distance between said lens system and the target sample, said lens system providing a generally uniform product of the target area times the solid angle captured by said lens system for relatively small variations in the distance between the lens system and the target sample.

19. A color measurement instrument as defined in claim 18 wherein said photo  
20 detector comprises:

- a photosensitive device having an image plane; and  
                  a mask adjacent said image plane and defining the target area viewed by said photosensitive device.

20. A color measurement instrument as defined in claim 18 wherein said illuminator provides generally spatially uniform illumination.